KOKAI PATENT APPLICATION NO. HEI 5[1993]-230426

ADHESIVE SHEET FOR BONDING OF WAFER AND CHIP PICKUP METHOD

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ADHESIVE SHEET FOR BONDING OF WAFER AND CHIP PICKUP METHOD

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[There are no amendments to this patent.]

(54) [Title of the invention]

An adhesive sheet for bonding of wafer and chip pickup method

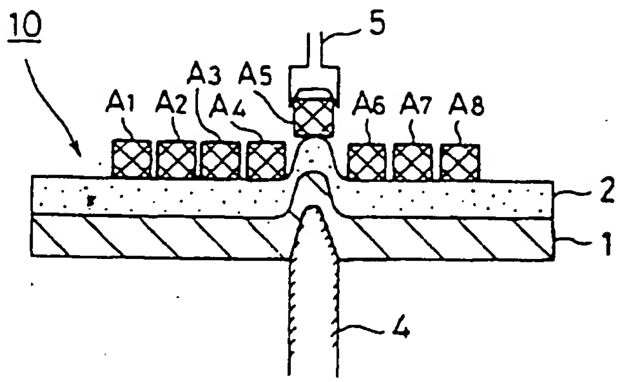
(57) [Summary]

[Constitution]

In an adhesive tape for wafer dicing, a film made of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$ MPa, and a film with a dimensional recovery factor greater than 80% is used for the base film.

[Effect]

The expansion process commonly included for adhesive sheet at the time of chip pickup can be eliminated.



[Claims of the invention]

[Claim 1]

In an adhesive sheet for wafer bonding comprised of a base film and an adhesive layer, the base film of the adhesive sheet for wafer bonding is comprised of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$ and a dimensional recovery factor greater than 80%.

[Claim 2]

The adhesive sheet for wafer bonding described in claim 1, in which the above-mentioned rubber-like elastic material is comprised of a natural rubber, isoprene rubber, 1,2-butene rubber, styrene-butadiene rubber, acrylonitrile-butadiene copolymer rubber, or vulcanized materials thereof.

[Claim 3]

A chip pickup method consisting of bonding a wafer onto a wafer bonding adhesive sheet consisting of a base film comprised of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$ and a dimensional recovery factor greater than 80%, and an adhesive layer; dicing said wafer to form a chip, transferring said adhesive sheet to the pickup machine without expansion, pressing the chip upward with a push pin from the backside of the adhesive sheet, and picking the chip up with a vacuum collet.

[Detailed explanation of the invention]

[0001]

[Application field of industry]

The present invention pertains to an adhesive sheet for wafer bonding and chip pickup method, and it further pertains to an adhesive sheet for wafer bonding and a chip pick-up where expansion process of adhesive sheet commonly included in chip pick-up can be eliminated.

[0002]

[Background of the invention]

Semiconductor wafers such as silicon and gallium-arsenic are produced as a product with a large size, and said wafers are subjected to dicing followed by mounting process. In this case, semiconductor wafers are subjected to a process consisting of dicing, washing, drying, expansion, pickup, and mounting while bonded to an adhesive sheet. The expansion process consists of stretching the adhesive tape with the diced chips bonded to it to expand the distance between chips so as to make chip pickup easier.

[0003] For the above-mentioned semiconductor wafers, wafers with [maximum dimensions] less than 6 inches have been used in the past, but with recent developments in the semiconductor industry, use of wafers with a greater diameter, for example 8 inches, has been suggested to increase productivity. Needless to say, when wafers with 8 inch diameters are used, the scale of the dicing machine and the bonding (pickup) machine are increased. Since the number of the chips produced increases, an expansion device with an increased size is required to provide sufficient chip distance.

[0004] For this reason, an adhesive tape for bonding with the wafer that is capable of providing accurate chip pickup under compact conditions without causing contact of the chips has been in demand.

[0005]

[Objective of the invention]

The objective of the present invention is to eliminate the above-mentioned problems with the conventional technology, and to provide an adhesive sheet for wafer bonding and chip pickup method that does not required the expansion process for the adhesive sheet that is commonly included in the chip pickup process.

[0006]

[Outline of the invention]

The feature of the present invention is that, in an adhesive sheet for wafer bonding made of a base film and an adhesive layer, the base film of the adhesive sheet for wafer bonding is comprised of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$ and a dimensional recovery factor greater than 80%.

[0007]

The feature of the chip pickup method of the present invention is that the method consists of bonding a wafer onto an adhesive sheet for wafer bonding made of a base film comprised of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$ and a dimensional recovery factor greater than 80% and an adhesive layer, dicing said wafer to form a chip, transferring said adhesive sheet to the pickup machine without expansion, pressing the chip upward with a push-up pin from the backside of the adhesive sheet, and collecting chips with a vacuum collet.

[0008]

[Detailed explanation of the invention]

As an adhesive sheet for wafer bonding concerning the present invention, for example, an adhesive sheet 10 produced by depositing an adhesive layer 2 on the base film 1 shown in Figure 1 can be mentioned. In order to protect adhesive layer 2 before use of adhesive sheet 10, it is desirable to provide release sheet 3 on the upper surface of adhesive layer 2.

[0009]

The form of adhesive sheet 10 used in the present invention can be a tape or a label, and it is not especially limited. For base film 1, a base film made of a rubber-like elastic material with a Young's modulus of $10^{-1} \sim 10^{2}$, is suitable, and a Young's modulus of $10^{-1} \sim 10^{1}$ is further desirable. The dimensional recovery factor of the above-mentioned rubber-like elastic material is greater than 80%, and greater than 90% is further desirable. The dimensional recovery factor is measured by the method shown below.

[0010]

The rubber-like elastic material is formed into a sheet with dimensions of 15 mm x 100 mm, the sheet is then drawn by 25% (25 mm) in the longitudinal direction as weight is being applied, the sheet is left standing under said conditions for 10 minutes, and the ratio between the length the sheet contracts to when the weight is removed and the incremental length of drawn sheet (25 mm) is measured.

[0011]

[Equation 1]

Dimensional recovery factor (%) = [X / 25]x100

[0012]

For rubber-like elastic materials having the above-mentioned Young's modulus and dimensional recovery factor, specifically, materials made of natural rubbers, isoprene rubber, 1,2-butene rubber, styrene-butadiene rubber, acrylonitrile-butadiene copolymer rubber, or vulcanized materials thereof can be mentioned. In general, the thickness of base film 1 made of the above-mentioned rubber-like elastic material is 30~150 μm, and 30~80 μm is preferable.

[0013]

The base film made of the above-mentioned rubber-like elastic materials exhibits a high degree of stretchability, and selective expansion can be achieved through application of an appropriate weight to a part of the base film alone. For this reason, the expansion process provided for the entire base film convention used is no longer required. In other words, chip pickup can be achieved without expansion. Provided that "without expansion"

means that the expansion ratio of the film based on the entire length of the base film is less than 3%.

[0014]

Widely available conventional adhesives can be used for the adhesive that comprises adhesive layer 2 deposited on base film 1, and acrylic type adhesives are especially suitable. Specifically, acrylic polymers selected from homopolymers and copolymers having acrylic acid ester as the main structural component, copolymers of these with functional monomers, and mixtures thereof can be mentioned. For example, an acrylic acid ester of an alkyl alcohol with 1 ~ 10 carbons, a methacrylic acid ester of an alkyl alcohol with 1 ~ 10 carbons, vinyl acetate, acrylonitrile, vinyl alkylether, etc. can be effectively used. Furthermore, the above-mentioned copolymers can be used independently, or in combinations of two or more.

[0015]

For functional monomers, of acrylic acid, methacrylic acid, maleic acid, 2-hydroxyethylacrylate, 2-hydroxyethylmethacrylate, etc. can be used. It is possible to adjust the adhesive strength and the cohesiveness of adhesives comprised of copolymers containing functional monomers when they are used in combination with crosslinking agents. For said crosslinking agents, polyhydric isocyanate compounds, polyhydric epoxy compound, polyhydric aziridine compounds, chelate compounds, etc. can be mentioned. Specifically, for polyhydric isocyanate compounds, toluylene diisocanate, diphenylmethane diisocanate, hexamethylene diisocanate, isophorone diisocanate, and adducts thereof, etc., can be mentioned. For specific examples of polyhydric epoxy compounds, ethylene glycol diglycidylether, terephthalic acid diglycidylester acrylate, etc. can be mentioned. For

specific examples of polyhydric aziridine compounds, tris-2,4,6-(1-aziridynyl)-1,3,5-triazine, tris[1-(2-methyl)-aziridinyl]phosphine oxide, hexa[1-(2-methyl)-aziridinyl]triphosphatriazine, etc. can be mentioned. For chelating compounds, specifically, ethylacetoacetate aluminum diisopropylate, aluminum tris(ethylacetoacetate), etc. can be mentioned.

[0016]

The molecular weight of the acrylic type copolymers produced upon polymerization of the above-mentioned monomers is $1.0x10^5 \sim 10.0x10^5$, and $4.0x10^5 \sim 8x10^5$ is further desirable. Furthermore, adhesive materials that undergo curing upon application of radiation, and are capable of having the adhesive strength reduced at the time of the pickup can be used for the adhesive layer. Specifically, an adhesive produced by mixing a radiation-curable polymeric compound with the above-mentioned main component acrylic copolymer can be mentioned. For the above-mentioned radiation polymerizable compounds, compounds with a low molecular weight containing two or more photopolymeric carbon-carbon double bonds in the molecule and capable of forming a three-dimensional mesh structure upon application of radiation such as those described in Japanese Kokai Patent Application No. Sho 60[1985]-196956 and 60[1985]-223139 can be mentioned. Specifically, trimethylolpropane triacrylate, tetramethylolmethane tetraacrylate, pentaerythritol triacrylate, pentaerythritol tetraacrylate, dipentaerythritol monohydroxypentaacrylate, dipentaerythritol hexaacrylate, 1,4-butylene glycol diacrylate, 1,6-hexanediol diacrylate, polyethylene glycol diacrylate, commercial oligoester acrylate, etc. can be mentioned.

[0017]

In addition to the above-mentioned acrylate compounds, urethane acrylate type

oligomers can be used as radiation polymerizable compounds. Said urethane acrylate oligomers can be produced by reacting an end-isocyanate urethane prepolymer produced by the reaction of polyol compounds such as polyesters and polyols with a polyhydric isocyanate compound such as 2,4-tolylene diisocanate, 2,6-tolylene diisocanate, 1,3-xylylene diisocanate, 1,4-xylylene diisocanate, and diphenylmethane 4,4-diisocanate and an acylate or a methacrylate having a hydroxyl group, for example, 2-hydroxyethylacrylate, 2-hydroxymethylmethacrylate, 2-hydroxypropylacrylate, 2-hydroxypropylmethacrylate, polyethylene glycol acrylate, or polyethylene glycol methacrylate. Said urethane acrylate oligomers are radiation polymerizable compounds having at least one carbon-carbon double bond.

[0018]

When urethane acrylate oligomers with a molecular weight of 3000 ~ 30000, preferably 3000 ~ 10000, and especially 4000 ~ 8000, are used, adhering of the adhesive to the surface of the chip at the chip pickup time, even when the surface of the semiconductor wafer is rough, does not occur, and therefore, it is desirable. Also, when said urethane acrylate oligomer is used as a radiation polymerizable compound, an adhesive sheet with higher adhesive properties can be produced compared with the case where a compound with a low molecular weight having two or more polymeric carbon-carbon double bonds in the molecule described in Japanese Kokai Patent Application No. Sho 60[1985]-196956 is used. That is, the adhesive strength is sufficiently high before radiation, but the adhesive strength is reduced after application of radiation, and the adhesive is less likely to be remain on the surface of the chip at the time of chip pickup.

[0019]

The mixing ratio of the acrylic adhesive and urethane acrylate oligomer in the adhesive is in a range of 50～900 parts by weight of urethane acrylate oligomer for 100 parts by weight of acrylic adhesive. In this case, the initial adhesive strength is high in the adhesive sheet, but the adhesive strength is drastically reduced after application of radiation, and the wafer chip can be easily picked from the adhesive sheet.

[0020]

In addition to the above-mentioned adhesive and radiation polymerizable compound, a compound that forms color upon application of radiation can be further included in adhesive layer 2. When the compound that undergoes change in color after radiation is included in the adhesive layer 2, the detection accuracy at the time of detection of the wafer chip by a photo-sensor can be further improved, and malfunction is less likely to occur at the time of chip pickup. Furthermore, application of radiation can be easily confirmed visually.

[0021] The compound that undergoes a change in color upon application of radiation is initially colorless or pale in color, but forms a color after application of radiation. For specific example of said compound, leuco dyes can be mentioned. For leuco dyes, standard triphenylmethanes, fluorans, phenothiazine, olamines, and spiropyrans can be mentioned. Specifically, 3-[N-(p-tolylamino)]-7-anilinofluoran, 3-[N-(p-tolyl)-N-methylamino]-7-anilinofluoran, 3-[N-(p-tolyl)-N-ethylamino]-7-anilinofluoran, 3-diethylamino-6-methyl-7-anilinofluoran, Crystal Violet lactone, 4,4',4''-trisdimethylaminotriphenylmethanol, 4,4',4''-trisdimethylaminotriphenylmethane, etc. can be mentioned.

[0022]

For developing agents that can be used in combination with the above-mentioned leuco dyes, initial polymers of phenol formalin resin, aromatic carboxylic acid derivatives, activated clay and other conventional electron acceptors can be mentioned, and when color change is desired, different kinds of conventional colorants can be used in combination. The above-mentioned compounds that undergo change in color upon radiation can be first mixed with an organic solvent, then, included in the adhesive layer, or included in the adhesive layer as a fine powder. The mixing ratio of the above-mentioned compound in the adhesive layer is 0.01 ~ 10 wt%, and a range of 0.5 to 5 wt% is further desirable. When the mixing ratio of said compound exceeds 10 wt%, an excessive amount of the radiation applied to the adhesive sheet is absorbed by the compound, as a result, curing of the adhesive layer becomes inadequate, in some cases; on the other hand, when the mixing ratio is less than 0.001 wt%, an adequate change in the color of the adhesive sheet cannot be achieved, and malfunction is likely to occur at the time of chip pickup.

[0023]

Furthermore, in addition to the above-mentioned adhesive and radiation polymerizable compounds, light scattering inorganic powders can be included in the adhesive layer 2. When a light scattering inorganic powder is included in the adhesive layer, even when the bonding surface of the semiconductor wafer is changed to gray or black for some reason, the adhesive strength is adequately reduced in the gray or blackened area when radiation such as ultraviolet radiation is applied to the adhesive sheet, as a result, adsorption of the adhesive to the surface of the wafer chip does not occur, but it provides adequate adhesive strength prior to irradiation.

[0024]

The above-mentioned light scattering inorganic compounds are compounds capable of reflecting ultraviolet radiation (UV) or electron beam (EB) when applied, and specifically, silica powders, alumina powders, silica-alumina powders, mica powders, etc. can be mentioned. It is desirable for the above-mentioned inorganic compounds to reflect all of the radiation, but those that absorbed radiation up to a certain degree can also be used.

[0025]

A powder-form is desirable for the above-mentioned inorganic compounds, and a particle diameter of 1 ~ 100 μm is desirable, and 1 ~ 20 μm is further desirable. It is desirable for the above-mentioned inorganic compound to be included in the adhesive layer at a ratio of 0.1 to 10 wt%, and 1 ~ 4 wt% is further desirable. When an amount greater than 10 wt% of said compound is included in the adhesive layer, the adhesive strength becomes poor, in some cases; on the other hand, when less than 0.1 wt% is used, an adequate reduction in the adhesive strength does not occur when radiation is applied to the surface of the gray or blackened semiconductor wafer, and adhesive is likely to be left on the surface of the wafer at the time of pickup.

[0026]

It is believed that an adequate reduction in the adhesive strength achieved in the adhesive sheet produced by mixing a light scattering inorganic compound powder with an adhesive layer upon application of radiation to the grayed or blackened area of semiconductor wafer that became gray or black for some reason is based on the reason provided below. That is, adhesive sheet 10 used in the present invention has adhesive layer 2, and when

radiation is applied to adhesive layer 2, the radiation polymerizable compound included in said adhesive layer undergoes curing and the adhesive strength is reduced. Grayed or blackened area appears on the semiconductor wafer for some reason at times. When radiation is applied to the adhesive layer, the radiation penetrates the adhesive layer and reaches the surface of the wafer, but when a grayed or blackened area exists on the wafer surface, the radiation is absorbed by said area, and reflection does not occur. Thus, the radiation initially applied for curing of the adhesive layer is absorbed at the grayed or blacked area, and curing of the adhesive layer becomes inadequate, and the adhesive strength cannot be adequately reduced. As a result, the adhesive is bonded to the chip at the time of the wafer chip pickup.

[0027]

However, when the above-mentioned light scattering inorganic compound is added to the adhesive layer, the radiation applied collides with the compound before reaching the wafer, and the direction [of the ray] is changed. In this case, the reflected radiation reaches the area above the grayed or blacked area of wafer chip, as a result, an adequate curing is achieved at said area as well. Therefore, when a light scattering inorganic compound powder is added to the adhesive layer, and adequate curing can be achieved at the area where the surface of the semiconductor wafer becomes gray or black for some reason, as a result, bonding of the adhesive to the surface of the chip can be avoided at the time of chip pickup.

[0028]

Furthermore, abrasive grains may be dispersed in the base film of the present invention. The grain diameter of the abrasive is $0.5 \sim 100$ μm, preferably $1 \sim 50$ μm, and the

Moh's hardness is $6 \sim 10$, and $7 \sim 10$ is further desirable. Specifically, green carborundum, artificial corundum, optical emery, white alundum, boron carbide, chrome oxide (III), cerium oxide, diamond powder, etc. can be mentioned. Either colorless or white grains are desirable. The mixing ratio of the above-mentioned abrasives is $0.5 \sim 70$ wt% for the base film, and $5 \sim 50$ wt% is further desirable. Use of abrasive grain is especially suitable when the base film is cut along with the wafer with a cutting blade.

[0029]

When the above-mentioned abrasive grain is included in the base film, clogging can be easily eliminated through the polishing effect of the abrasive grain when the adhesive is adsorbed on the cutting blade as the base film is cut. When crosslinking agents are used in combination with the above-mentioned adhesive, the adhesion and cohesion can be set to the desired degree. For examples of crosslinking agents, polyhydric isocyanate compound, polyhydric epoxy compound, polyhydric aziridine compound, chelate compound, etc. can be mentioned. For polyhydric isocyanates, specifically, toluylene diisocanate, diphenylmethane diisocanate, hexamethylene diisocanate, isophorone diisocanate, and adduct types thereof can be mentioned. For examples of polyhydric epoxy compounds, specifically, ethylene glycol diglycidylether, terephthalic acid diglycidylester acrylate, etc. can be mentioned. For polyhydric aziridine compounds, specifically, tris-2,4,6-(1-aziridinyl)-1,3,5-triazine, tris[1-(2-methyl)-aziridinyl]phosphine oxide, hexa[1-(2-methyl)-aziridinyl]triphophortriazine, etc. can be mentioned. For chelate compounds, specifically, ethylacetoacetate aluminum diisopropyrate, aluminum tris(ethylacetoacetate), etc. can be mentioned.

[0030]

In the case when UV radiation is used, when UV initiators are included in the above-mentioned adhesive, the polymerization time and UV dosage can be reduced. For said UV initiators, specifically, benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzyldiphenylsulfide, tetramethylthiuram monosulfide, azobisisobutylonitrile, dibenzyl, diacetyl, ß-chloroanthraquinone, etc. can be mentioned.

[0031]

In the following, chip pickup procedure concerning the present invention is explained. When release sheet 3 is provided over the upper part of the adhesive sheet 10, said sheet 3 is removed, and the sheet is placed with the adhesive layer 2 of the adhesive sheet 10 facing upward, and semiconductor wafer A is bonded to adhesive layer 2. Wafer A is subjected to dicing, cleaning, and drying processes. At this time, the wafer chip is adequately bonded with the adhesive sheet via adhesive layer 2, the wafer chip does not come off during the above-mentioned processes.

[0032]

Subsequently, the wafer chip is picked up from the adhesive sheet, and mounted onto the prescribed base. In this case, ionizing ray such as ultraviolet radiation (UV) or electron beam (EB) is applied to adhesive layer 2 of the adhesive sheet 10 before pickup or at the time of pickup as shown in Figure 4 to provide sufficient curing of the radiation polymerizable compound included in adhesive layer 2. When radiation is applied to adhesive layer 2, and curing of the radiation polymerizable compound occurs, the adhesive strength is significantly reduced.

[0033]

It is suitable when application of radiation to the adhesive sheet 10 is performed from the side of the base film 1 where adhesive layer 2 is not deposited. When UV is used for the radiation source, it is necessary to use a light transmissive film for the base film 1, but when EB is used, a light transmissive film is not necessary.

[0034]

Radiation is applied to the adhesive layer 2 where wafer chips A_1, A_2 ...... are mounted, and the adhesive strength of the adhesive layer 2 is reduced, then, the adhesive sheet 10 is transferred to the pickup station. In the past, expansion of the adhesive sheet 10 is performed and the distance between chips is sufficiently increased before chip pickup, but when the adhesive sheet of the present invention for bonding of wafers is used, the above-mentioned expansion process can be eliminated. In other words, chip A1 .... to be picked up is bumped from the bottom of base film 1 by press pin 4 as shown in Figure 5. Base film 1 has an adequate Young's modulus and dimensional recovery factor; as a result, only the chip to be picked is bumped, and dislocation and dislodging of other chips does not occur. When press pin 4 is removed, the sheet immediately returns the initial flat condition, wrinkles or distortion do not remain in the sheet, and chip pickup can be done one after another without any problem. The chip pressed up from adhesive sheet 10 is picked by a vacuum collet, etc., and mounting is performed as usual. When chip pickup is performed for wafer chips A_1, A_2 ......, chip pickup can be smoothly performed without the above-mentioned expansion process for the adhesive sheet.

[0035]

It is not necessary to apply the radiation to the entire bonded surface of wafer A all at once, for example, radiation may be applied to the backside of each wafer chip A_1, A_2..... one at a time as they are to be picked up. A modified example of the above-mentioned radiation application method is shown in Figure 6. In this case, a tubular press pin 4 is used and radiation source 6 is installed inside said pin, and radiation application and pickup is simultaneously performed. In this manner, the device can be simplified, and the pickup time can be further reduced.

[0036] [Effect of the invention]

As explained above, according to the method of the present invention, it is possible to eliminate the expansion process, and chip pickup can be performed using a compact device even when a wafer with a greater diameter is used.

[0037]

[Application example]

In the following, the present invention is further explained with an application example, but the present invention is not limited to the example.

[0038]

[Application Example]

An acrylic adhesive (n-butylacrylate and acrylic acid copolymer) was coated onto a base film (thickness of 40 μm) made of vulcanized natural rubber to form a thickness of 10 μm, and an adhesive sheet was produced. An 8-inch silicon wafer was bonded to the adhesive layer of the adhesive sheet produced, and dicing of the wafer was performed; then,

chip pickup was performed using a non-extended type die bonder. Conditions used for dicing and pickup are shown below.

[0039]

Depth of dicing: 20 μm from the tape surface

Press pin: 4 pins

Diameter of the bonding holder: 28 mm diameter

Collet: Pyramid collet

Bumping height: 2 mm

Dicing size: 8mm x 8mm

As a result, good chip pickup operation was achieved without tape damage due to chip contact, or malfunction of the device due to warping of the tape.

[0040]

[Comparative Example]

In the above-mentioned application example, a vinyl chloride film (thickness of 40 μm) was used for the base film, and operation was performed as before. Dislocation of the chips occurred during pickup due warping of the tape and failure of dimensional restoration, and malfunction of the bonding equipment resulted.

[Brief explanation of figures]

[Figure 1] Schematic cross-section of the adhesive sheet for wafer bonding of the present invention.

[Figure 2] Schematic cross-section of the adhesive sheet for wafer bonding of the present invention.

[Figure 3] Explanatory drawing of the chip pickup method of the present invention. [sic]

[Figure 4] Explanatory drawing of the chip pickup method of the present invention. [sic]

[Figure 5] Explanatory drawing of the chip pickup method of the present invention.

[Figure 6] Explanatory drawing of the chip pickup method of the present invention.

[Explanation of codes]

1...Base film

2...Adhesive layer

3...Release sheet

4...Press pin

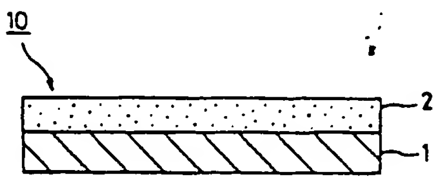
5...Vacuum collet

6...Radiation source

A...Wafer

B...Radiation

【図1】



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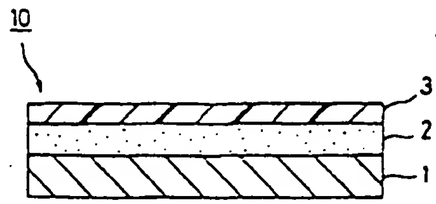

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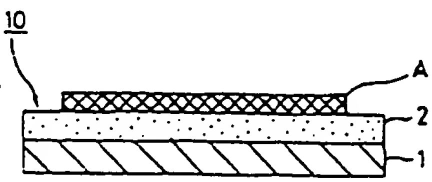

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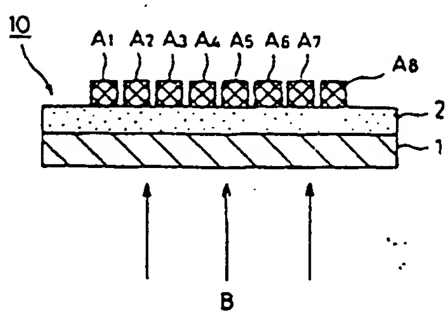

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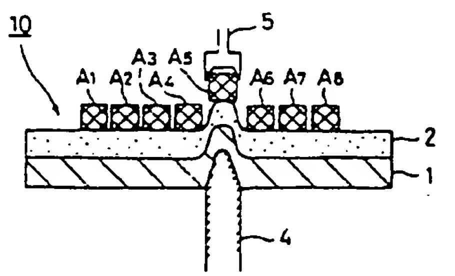

【図6】